Acquisition Directorate

Research & Development Center

CSSC Fish Barrier Simulated Rescuer Touch Point Results, Operating Guidance, and Recommendations for Rescuer Safety

PUBLICATION NO: CG-D-01-12

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
FEB 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
CSSC Fish Barrier Simulated Rescuer Touch Point Results, Operating Guidance, And Recommendations For Rescuer Safety	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **United States Coast Guard,Acquisition Directorate,Research & Development Center,Washington,DC,20593**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

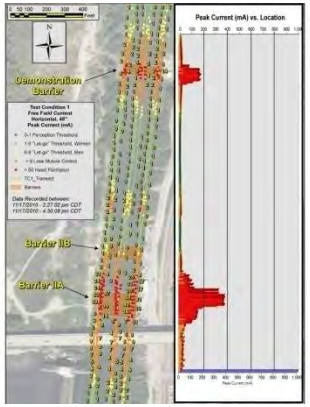
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**19**	

Introduction - Background

- U.S. Army Corps of Engineers (USACE) operates electric fish barriers in the Chicago Sanitary and Ship Canal (CSSC) to prevent dispersion of aquatic nuisance species
- Navy Experimental Diving Unit (NEDU) concluded a threat to human life is possible within the electrified zone due to voltage gradients present
- USCG Research and Development Center (RDC) (SAIC as contractor) conducted study to investigate safe rescuer response actions to assist a person-in-the-water (PIW)

Project Approach

- **Meet stakeholders (USACE, local USCG, local responders) and tour facilities**
- **Review literature & data (USACE & NEDU)**
- **Design and conduct instrumented experiments**
  - Electrical touch point currents associated w/PIW rescue
- **Report on results**
  - Identify rescue performance gaps,
  - I.D. requirements for rescue equipment, devices, or procedures,
  - Make recommendations (incl. changes to response)



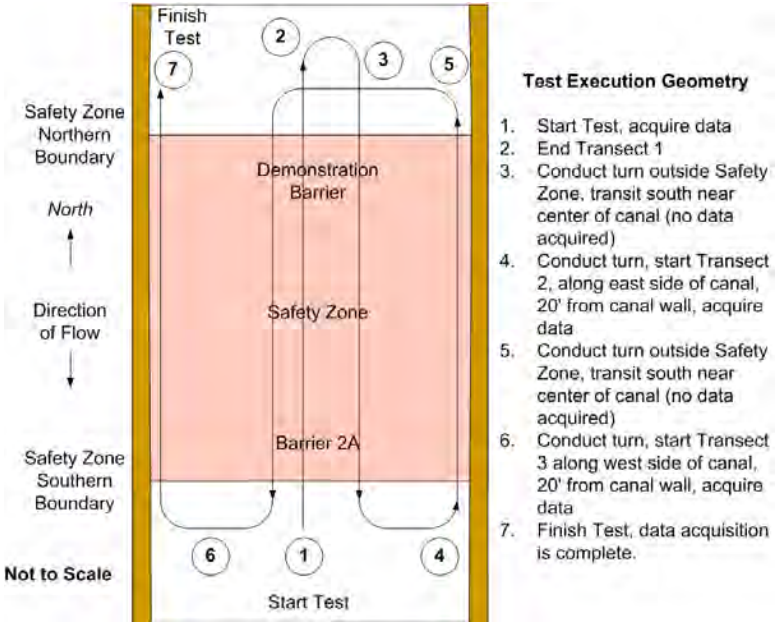
Literature Review

- **USACE tech reports on CSSC barrier fields**
- **NEDU report on risks of human immersion in CSSC**
- **Publically available literature**
- **Summary**
  - USACE info as basis for test instrumentation setup
  - Medical data focused on DC or 50-60 Hz AC shock, not repetitive DC shock
  - NEDU summary data for human physiological response established analysis thresholds for touch point currents:

Threshold currents (in milliamps):

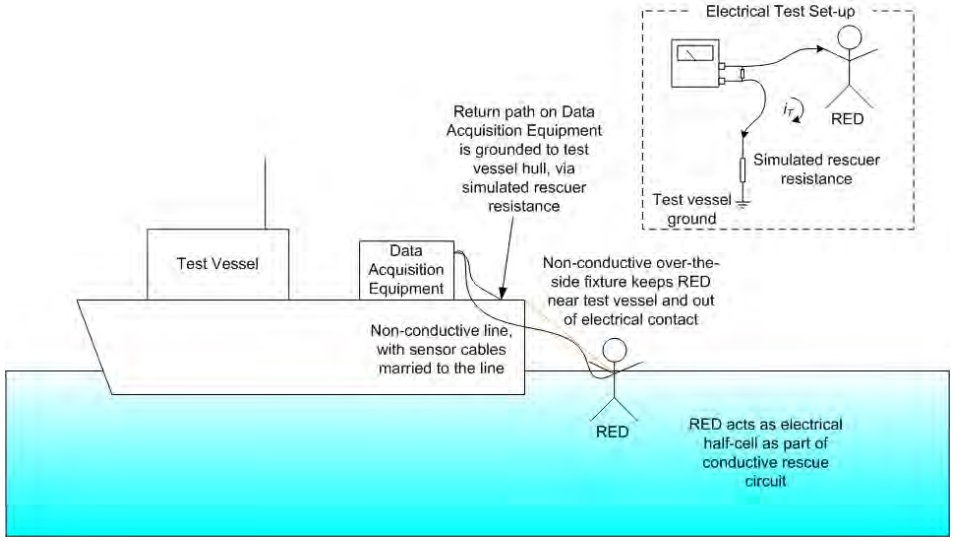
Experiment Test Plan

- Protocols for testing, safety, and communications
- Test conditions for rescue scenario touch point measurements
- Data acquisition and test apparatus



Test Execution Geometry

1. Start Test, acquire data
2. End Transect 1
3. Conduct turn outside Safety Zone, transit south near center of canal (no data acquired)
4. Conduct turn, start Transect 2, along east side of canal, 20' from canal wall, acquire data
5. Conduct turn outside Safety Zone, transit south near center of canal (no data acquired)
6. Conduct turn, start Transect 3 along west side of canal, 20' from canal wall, acquire data
7. Finish Test, data acquisition is complete.



Data Acquisition Setup

- **Local aluminum-hulled test vessel**

- **PIW simulated with electrode array**

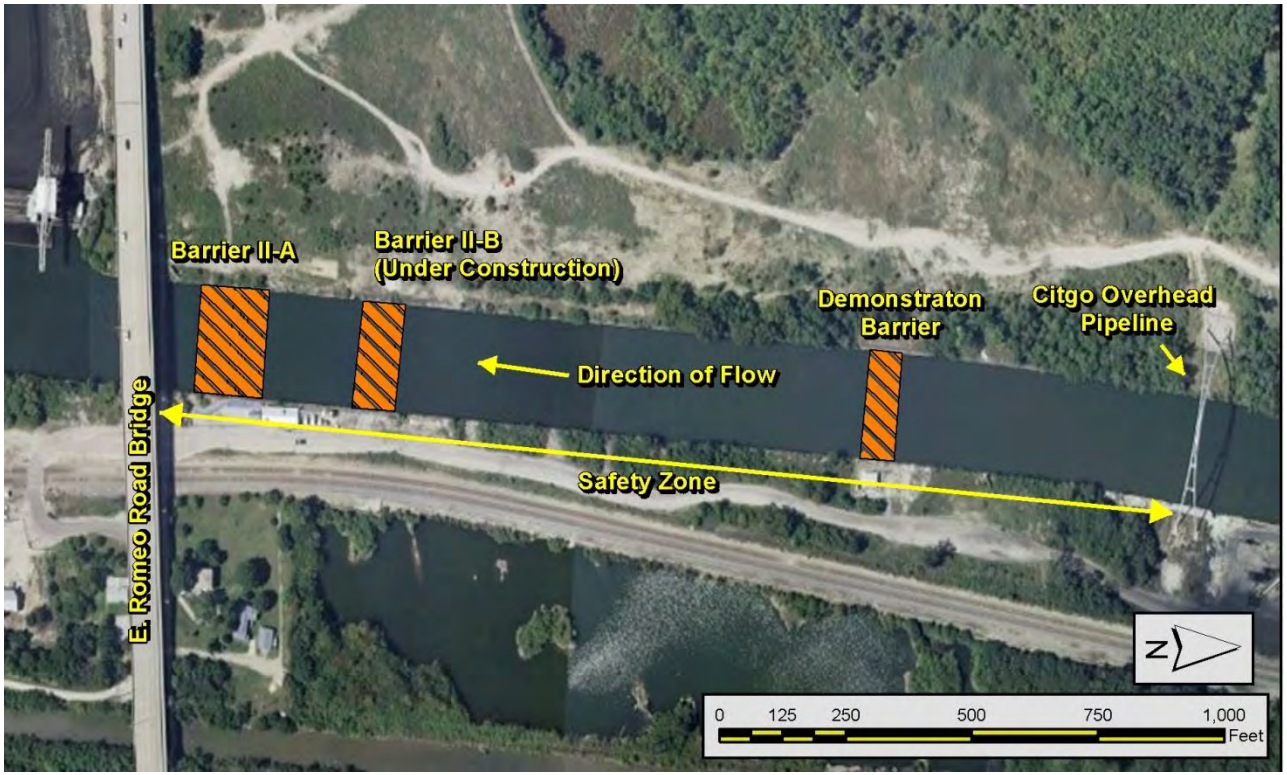
- **Automated data recording system**
  - Electrical data and GPS

Experiment Test Conditions

Test Condition	Description
Free-field current	Current flow through simulated PIW
Rescue vessel recovery touch point current	Current flow PIW to rescuer on aluminum hull
Shore recovery touch point current	Current flow PIW to rescuer on shore
Free-field current, dry suit	Current flow through PIW in dry suit, hands exposed
Life ring throw, polypropylene line	Current between PIW & rescuer using poly line
Life ring throw, nylon line	Current between PIW & rescuer using nylon line
Life ring throw, non-conductive rescue hook	Current between PIW & rescuer using hook
Surface voltage survey	Cross-check against USACE tests

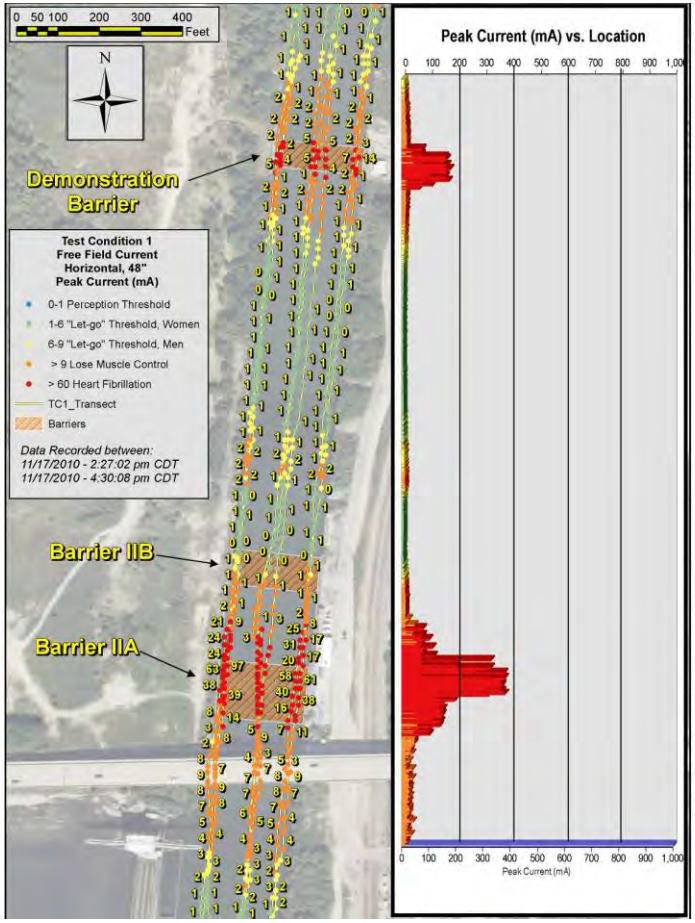
Data Collection

- Continuously recorded electrical and GPS data during data transects along the barrier zone
- Halted testing as necessary to not impede traffic in the CSSC

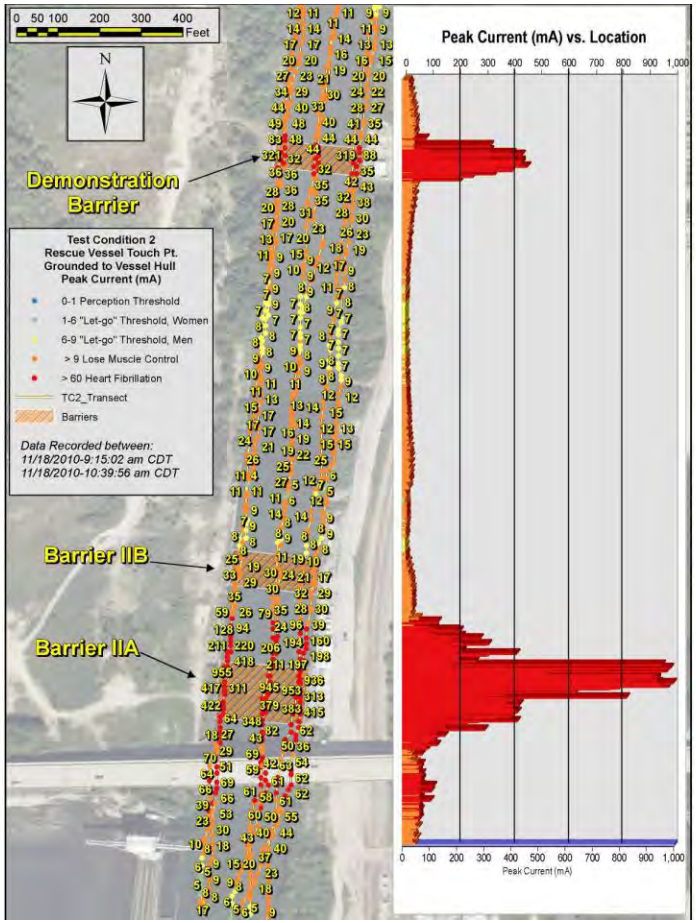


Data Analysis

- **Computed and charted peak currents**



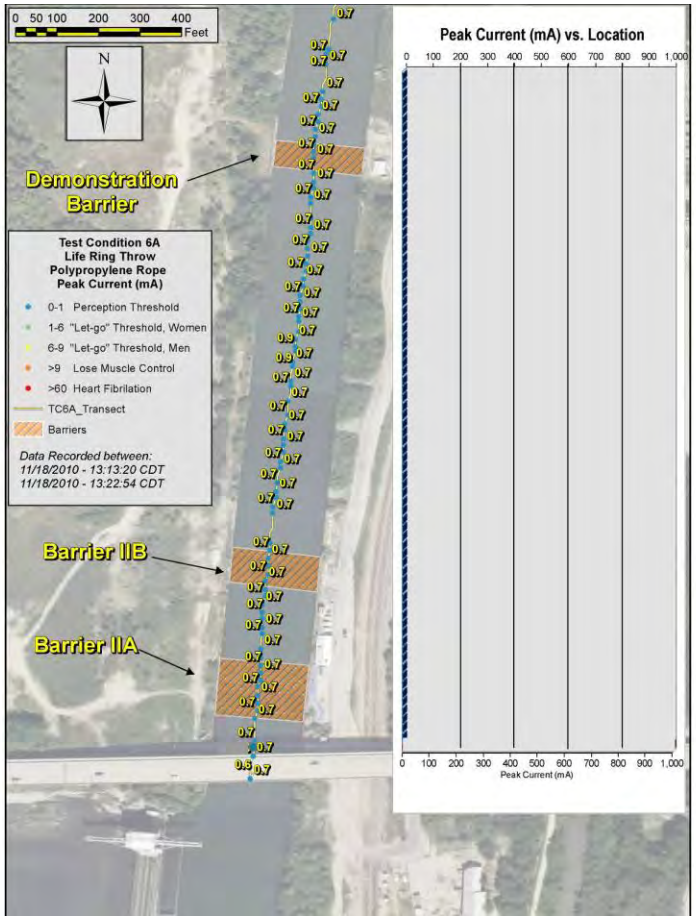
Free field current between horizontal electrodes, 48" apart, oriented parallel to vessel track (simulated PIW).



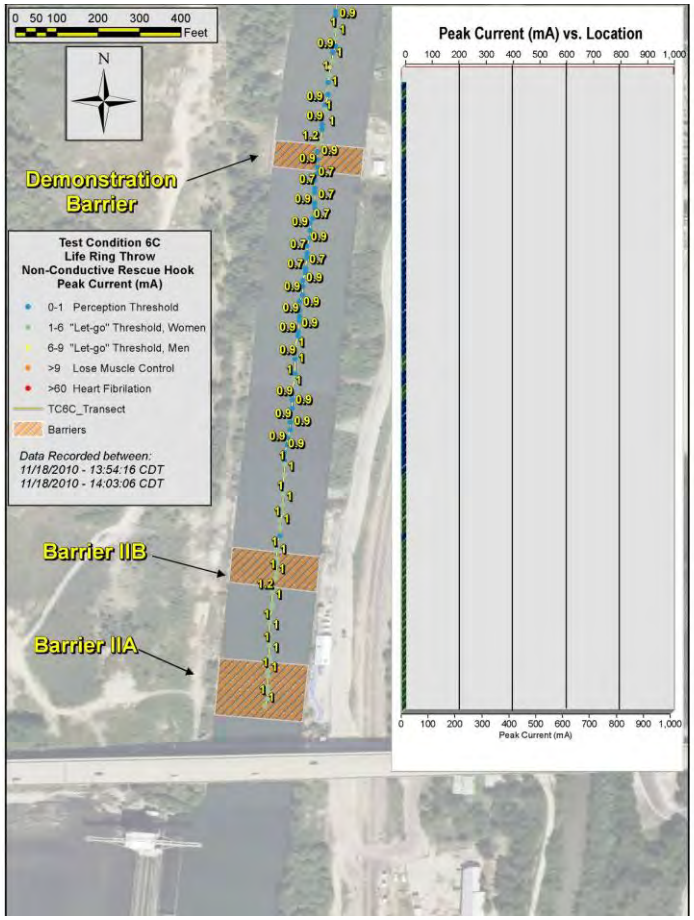
Touch point current between simulated PIW and simulated rescuer on an aluminum boat.

Data Analysis (Cont'd)

- **Computed and charted peak currents**



Peak current between polypropylene line & vessel.



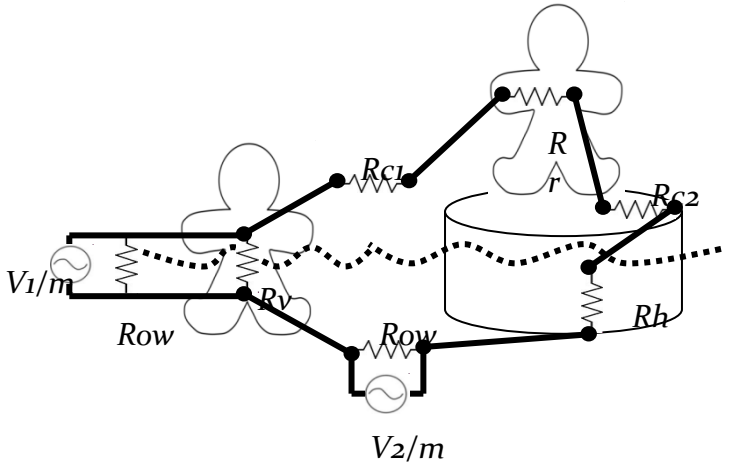
Peak current through non-conductive hook to vessel.

Results

Test Condition Description	Highest Measured Peak Touch Point Current to Rescuer (mA)
Free-field current	380
Rescue vessel recovery touch point current	973
Shore recovery touch point current	41
Free-field current, dry suit	Not evaluated
Life ring throw, polypropylene line	<0.7
Life ring throw, nylon line	1.2
Life ring throw, non-conductive rescue hook	<1.0
Surface voltage survey	Not evaluated; open circuit testing

Results (Cont'd)

- **Significant electrical currents within the electrified area**
- **Non-conductive materials effective at reducing touch point currents**
  - Polypropylene rope, rescue hook, lineman's gloves
- **Touch point currents with simulated rescuer & PIW highest when in direct contact with the aluminum hull**



Conclusions

- Humans floating through the electrified zone would be subjected to potentially lethal, through-the-body electric currents
- Electrical resistance of the simulated human body did not offer protection against the flow of electricity
- Simulated PIW in direct contact with a vessel metallic hull is more hazardous than no contact with the hull; rescue methods need to isolate the PIW from metallic objects

Conclusions (Cont'd)

- **Polypropylene rope & non-conductive rescue hook conducted very low amounts of current to a simulated rescuer on an aluminum boat**
- **In general, non-conductive or resistive materials are effective**
  - Rescuers must understand electrical current paths
  - Rescuers must take precautions to avoid becoming part of the electrical circuit

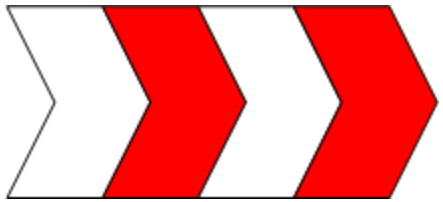
Lineman's glove

Poly rope

Non-conductive body rescue hook

Conclusions (Cont'd)

- **Touch point current with the canal wall were lower than in-water currents**
  - Shore-side rescue may be viable
- **Location of the actual electric fields was not well marked**
  - No easy, visual method on canal walls that indicate “less-hazardous” areas and actual extent of “hot” zone



Recommendations

WARNING

Under no circumstances should a rescuer enter or immerse any part of their body directly into the electrified waters in the CSSC. A rescuer should not make contact with any PIW (in the electrified area) unless the rescuer is electrically isolated from the PIW. Any attempt at rescue in electrified water conditions is inherently hazardous. These recommendations serve to mitigate hazards to rescuers, but not eliminate them. Nothing in these recommendations should be construed that rescue in electrified water is anything but a hazardous undertaking.

- **Do not let rescuer enter the water or immerse any body part in the vicinity of the barriers**
- **Use non-conductive tethers to prevent a rescuer from inadvertently entering the water, whether the rescuer is aboard a vessel or ashore**

Safety harness

Recommendations (Cont'd)

- **Use non-metallic hulled vessels to attempt rescue of a PIW in the barrier zone**
  - If rescuers must use a metallic hull, do not allow the metallic hull to make direct contact with the PIW
- **If unable to assist the PIW from a vessel, use a polypropylene throw-rope and life ring to reach the PIW from shore**
- **Use dielectric materials, including polypropylene line, non-conductive rescue hooks, and lineman's gloves, to provide a safer means of making contact with a PIW**
  - Use non-conductive materials to keep all rescuer body parts from making contact with the water or with the PIW while the PIW is in the electrified zone
  - Use the dielectric materials to move the PIW out of the electrified zone as quickly as possible

Recommendations (Cont'd)

- **In conjunction with USACE and local first responders, develop special markings for the canal walls to delineate the areas within the barrier zone that allow a greater degree of rescuer safety than others**
- **Provide all potential responders with a base level of electrical safety training**
  - Emphasize circuit awareness
  - Identify risks associated with electricity and water
  - Make aware of variations in rescue conditions in the CSSC electrified area
  - Make known the deleterious effects of even extremely low currents on individuals with implanted electrical devices

Next Steps

- **Conduct additional testing after USACE establishes permanent electrical configuration of CSSC**
  - Barrier IIB energized (with IIA and Demo barrier)
- **Use tools and techniques identified to date to test alternatives**
  - Use non-metallic (i.e. fiberglass) hulled vessel for “rescue” tests
  - Evaluate results of COTS rescue equipment